



Materials Engineering Branch

TIP*



No. 081 Galling of Stainless Steel

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Galling is defined as the tearing of metal surfaces under high load between contacting metal surfaces rendering the component unserviceable. Numerous cases of galling have been experienced on spacecraft components such as pins, threaded fasteners, valve seats and other sliding mechanisms. A major application where galling resistance is extremely important is that of release and engagement mechanisms used in conjunction with Shuttle payloads that require in-orbit removal from the cargo bay and subsequent recapture.

First, the mechanism, which consists of an arrangement of heavily loaded pins and sockets, must release the payload from a fixture in the cargo bay when it reaches the desired orbit. Then, when the mission is over and the payload is recaptured, it must be able to engage and maintain the payload in its safe position in the cargo bay for the return trip. The importance of proper operation of such mechanisms to the success of a mission is obvious.

Galling becomes more severe as the load increases and/or as the cleanliness of the contacting surfaces increases. It is particularly severe in a vacuum environment where protective metal oxides cannot re-form to prevent direct metal-to-metal contact. The most common protection against galling is lubrication of the contacting metal surfaces.

In general, stainless steels exhibit low resistance to galling, especially the 300 series stainless steels. These alloys are often selected for spacecraft components because of their outstanding corrosion resistance as well as their high resistance to stress-corrosion-cracking (SCC).

Nitronic 60 is an austenitic stainless steel that exhibits excellent galling resistance and has corrosion resistance similar to Type 304 stainless steel, but has only moderate resistance to SCC. Armco Steel Company tests where polished, unlubricated surfaces are rotated 360° under load, determined the threshold galling stress (the stress at which galling is first observed) of numerous combinations as presented below.

Metal	Threshold Galling Stress (PSI)	Resistance to Stress Corrosion Cracking
Type 304 Stainless	2,000	High
Type 440C	11,000	Low
Nitronic 60 Stainless	50,000*	Moderate

*Galling did not occur.

Note that because Nitronic 60 has only moderate resistance to SCC, it should not be used for applications where sustained tensile stresses are expected to exceed 25% of UTS.